



GREAT  
ORMOND  
STREET  
HOSPITAL  
CHARITY

Breakthroughs in children's medicine  
**HORMONES**



**WELCOME**





## Welcome

This guide will take you on a journey through the endocrine system, which produces the hormones that control our bodies. You'll share in the successes and challenges that Great Ormond Street Hospital (GOSH) has faced in this intriguing area of medical science.

I'm based in the endocrinology team at GOSH, where we provide one of the largest specialist services for children and young people with hormone problems, including diabetes, in Europe. More than 5,000 outpatients and 1,200 inpatients with some of the most complex hormonal conditions are referred to the hospital from all over the world each year. Research, and the breakthroughs it enables, are absolutely vital to what we do. We're constantly evolving to develop new treatments that are kinder and more effective for children and young people.

Left: Professor Mehul Dattani.

The wellbeing of our patients relies not only on the skill and expertise of doctors and researchers, but also the large number of people from across the hospital's multidisciplinary teams – from nurses and play specialists to dietitians and physiotherapists. Thanks to them, thousands of children have benefited from advances in treatment since the hospital opened more than 160 years ago.

I hope you enjoy reading about some of our achievements, which, in many cases, have only been possible thanks to supporters like you.

### Professor Mehul Dattani

Professor of Paediatric Endocrinology and Head of Section of Genetics and Epigenetics in Health and Disease at the UCL Great Ormond Street Institute of Child Health

Head of Paediatric Endocrinology at Great Ormond Street Hospital.

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Cover image: 11-year-old Louie with his mum, Karen.

## About the endocrine system

Our bodies house a complex endocrine system that controls the release of hormones into the body. Hormones are produced by glands and can regulate many things, from growth and development, to reproduction, sleep, and mood. In this guide, we will focus on four key components of the endocrine system:



Pituitary

Thyroid

Adrenal

Pancreas



## ● Pituitary

The pituitary gland is about the size of a pea, located at the base of the brain. It's responsible for many functions in the body, including growth, controlling blood pressure, temperature regulation, pain relief and some aspects of pregnancy.

## ● Adrenal

We have two adrenal glands, located above each of our kidneys. They produce a variety of hormones, including adrenaline, which plays an important role in the fight-or-flight response, and cortisol, which is released in response to stress and low blood sugar.

## ● Thyroid

The thyroid gland is located in the neck and is primarily responsible for controlling our metabolic rate (the energy needed by all the processes and chemical reactions that the body needs to function), but it also has other important functions.

## ● Pancreas

The pancreas is located behind the stomach. It produces many important hormones, including several that are key for regulating the amount of sugar in the blood. It's also a digestive organ, producing enzymes that help with the breakdown and absorption of nutrients from food.



Alexandra Ward at Great Ormond  
Street Hospital in the 1890s.

**YESTERDAY**









## What's in a name?

The partnership between University College London (UCL) and Great Ormond Street Hospital has been important throughout our history and continues to be to this day. Back in 1902, a young UCL researcher, Ernest Starling, and his colleague and brother-in-law, Sir William Maddock Bayliss, discovered the very first hormone – secretin, which regulates water in the body. Just three years later, Starling was the first person to coin the name and concept of hormones, a term that is still important in medicine today.

## Diabetes through the ages

One of the most well-known hormonal conditions is diabetes – cases have been recorded as far back as the time period of Ancient Greece, long before it was even known what a hormone was. In fact, when Great Ormond Street Hospital first opened its doors in 1852, there was still no effective treatment for the condition.

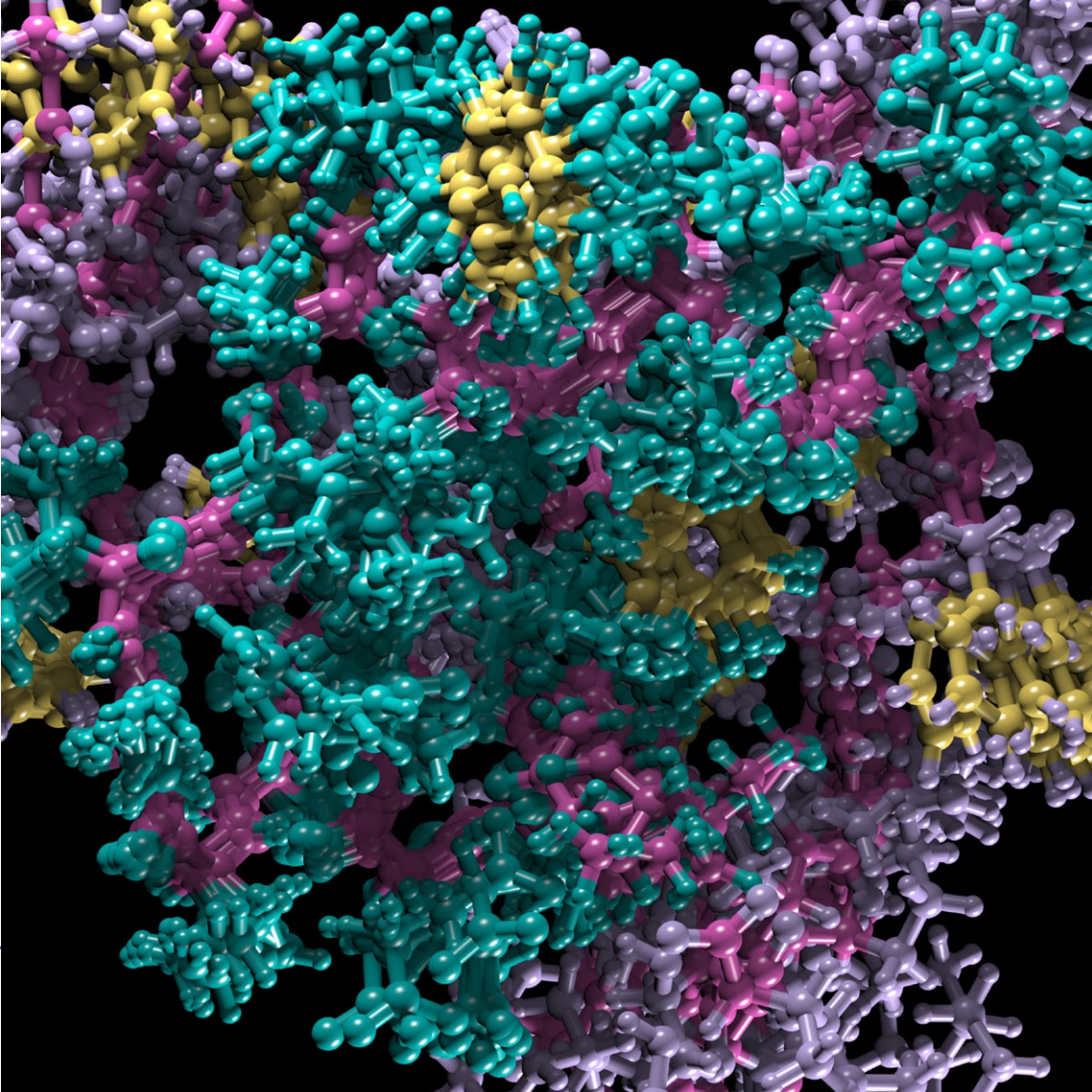
The role of the pancreas in the disease had been known as early as 1889, but it wasn't until 1910 that Sir Edward Albert Sharpey-Schafer identified that people with diabetes were deficient in a single chemical. He proposed calling this substance 'insulin', a hormone. The next step came in 1922 at the University of Toronto, when Sir Frederick Grant Banting and Charles Herbert Best purified insulin. This led to the availability of an effective treatment – insulin injections. Treatment with insulin rapidly spread around the world, including to Great Ormond Street Hospital.

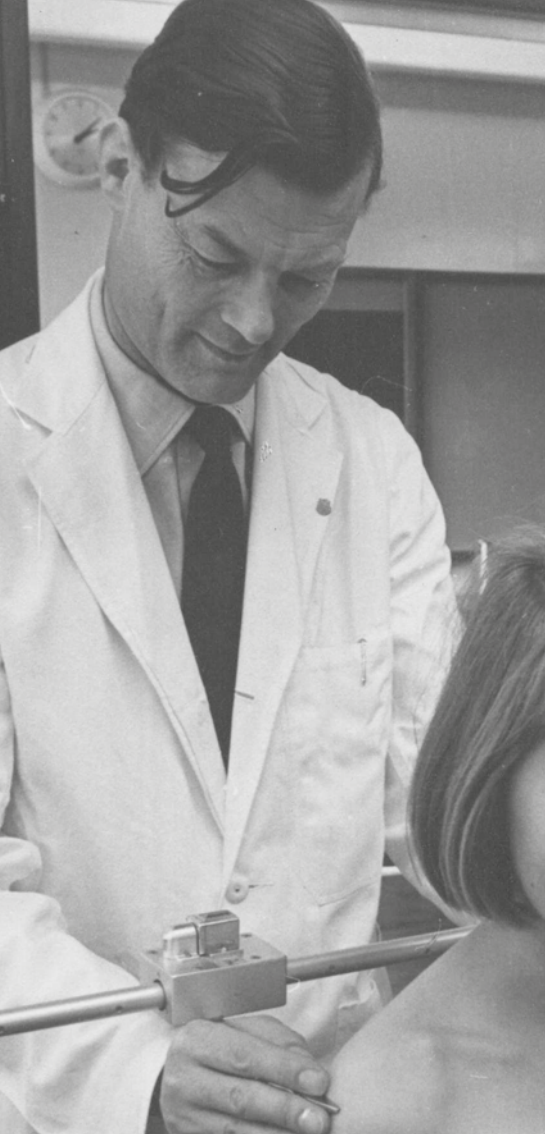
**Right: molecular model of insulin molecule.**

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**1852** The Hospital for Sick Children opens on Great Ormond Street.

**1889** Joseph von Mering and Oskar Minkowski discover that dogs who have had their pancreas removed developed all the signs and symptoms of diabetes.









## Early GOSH pioneers

In 1948, Dr James Tanner – who was based at Great Ormond Street Hospital – began work that would leave a mark on medicine for many years to come. His efforts led to the development of the Tanner scale – which tracks puberty in teenagers, driven by hormones – and paved the way for the modern growth chart. He also conducted early research on the use of human growth hormone to help children whose growth was significantly delayed, ushering in the treatments of the future.

In 1974, David Beattie Grant was named the UK's first consultant paediatric endocrinologist (childhood hormonal specialist) at Great Ormond Street Hospital. Despite a heavy clinical load, he continued his research work and was particularly interested in congenital hypothyroidism, a condition that affects the thyroid gland and is still treated at the hospital today (see page 21).

Far left: Dr James Tanner.

Left: David Beattie Grant.

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**1902** The first hormone, secretin, is discovered by researchers Ernest Starling and Sir William Maddock Bayliss at University College London.

**1905** Ernest Starling first introduces the concept of hormones.

**1963** Insulin becomes the first protein to be chemically synthesised.





Gabriella came to Great Ormond Street as a baby and was cared for on Squirrel Ward.

**TODAY**





## The small gland with a big role

Professor Mehul Dattani is a world-leader in paediatric disorders of the pituitary gland, a pea-sized gland found at the bottom of the brain that controls growth and development. One disorder that he specialises in is septo-optic dysplasia (SOD), which affects about one in 10,000 babies.

Children with SOD are often completely blind, have underdeveloped pituitary glands, and have poorly formed sections of the brain, which can lead to intellectual impairment and neurological problems. It is a life-threatening condition and can cause death if not diagnosed and treated quickly. There is no cure, but a variety of hormones can be used to help manage symptoms.

In 1998, Professor Dattani led a study that discovered the first gene associated with SOD. Since then, his team have identified new genes linked to this, and other, pituitary disorders. These discoveries are helping to change practice, allowing

doctors to determine and more accurately predict major problems that are going to arise, and allow earlier treatment of hormonal disorders that might have been otherwise undiagnosed. These breakthroughs will eventually lead to better care of children with these disorders.

Owing to Professor Dattani's research, Great Ormond Street Hospital has one of the largest cohorts of patients with SOD, now treating around 200 children, and a further 300 with other forms of congenital hypopituitarism. "Our aim is to better understand brain, pituitary and eye development," explains Professor Dattani. "We want to diagnose the condition sooner, and detect complications earlier.

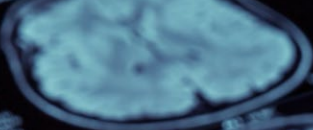
"Ultimately, we want to personalise the management of each child with SOD and improve their quality of life."

**Right: MRI scans are used to look at the brain and pituitary gland.**

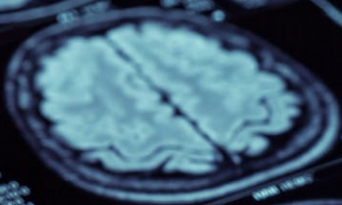
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**1994** The X-linked form of congenital adrenal hypoplasia was first identified.

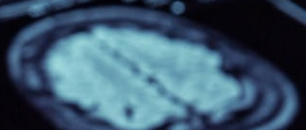
**1998** Professor Mehul Dattani discovers the first gene associated with septo-optic dysplasia, a disorder of the pituitary gland.



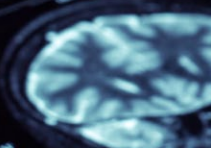
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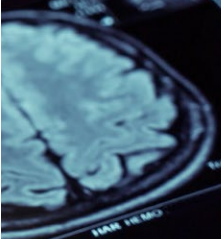
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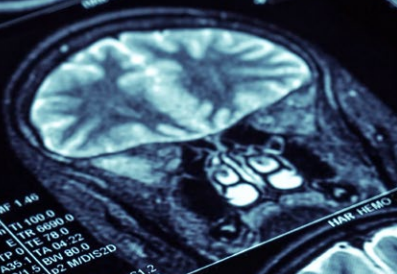
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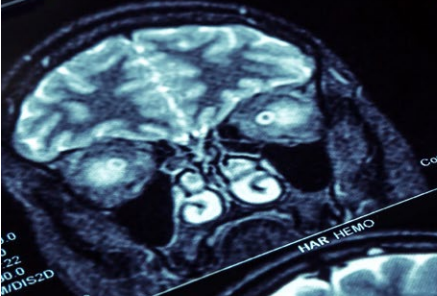
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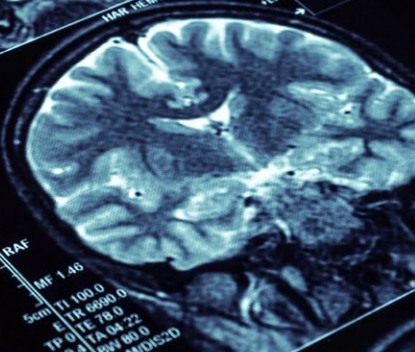
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## Meet Louie

Louie has been treated at Great Ormond Street Hospital since he was four months old for septo-optic dysplasia (SOD), a condition that mainly affects his sight and his brain. Louie is registered blind, takes a lot of medication and could slip into a coma at any time.

Louie is an energetic boy; he loves Formula one, judo and creating music on his iPad. His favourite doctor is Professor Mehul Dattani.

"Louie became unwell within about 10 hours of being born," says mum, Karen.

"He has a twin, Aiden, so we were back and forth between special care and the maternity ward for two weeks before going home.

"By the time Louie was six weeks old, he'd had two blood transfusions, antibiotics and multiple daily blood tests. We were later referred to Great Ormond Street Hospital for further opinions.

"At four months old, Louie had an eye test and I was told he was completely blind. It was really hard to get that news, but my first thought was that I needed to be strong for my two boys.

"We saw Professor Dattani, who seemed to immediately know what was wrong. He tested Louie and diagnosed SOD.

"Louie started treatment and we began learning about his condition. He'll always need medication and to carry his emergency medication pack. There is always the worry that something could trigger him to fall into a coma, but with the hospital's help we're hopeful for the future."

Right: 11-year-old Louie with his twin brother, Aiden.









## Thyroid: when subtleties matter

The thyroid produces hormones that control growth and development, but sometimes, a fault means that the gland doesn't produce enough of those hormones. This leads to a condition called hypothyroidism. All babies in the UK are now screened for the condition, and Dr Catherine Peters works in the thyroid team at Great Ormond Street Hospital, which deals with some of the 160 referrals a year.

"The screening programme was introduced across the UK in 1983, and it's been a major public health success," says Dr Peters. "Now we're researching whether subtler changes could lead to milder forms of hypothyroidism that could require treatment. These changes could mean that we'll avoid some of the side effects of the condition, such as learning difficulties."

The team have also discovered that there is a type of hypothyroidism present at birth, which disappears over time, but it can return. "We've identified genes that cause this hypothyroidism, which means that we can work with children differently and help them understand the implications for when they have their own children," says Dr Peters.

The team are trying to understand more about the causes of the disease: "We've found that there are ethnic differences – some eastern Asian populations are more likely to have higher levels of some thyroid hormones and it seems there is something different in their genetic biology. This is helping us to learn about why hypothyroidism arises, which will be vital in identifying and treating more children in the future."

Left: Dr Catherine Peters.







## Pancreas: changing the way that we treat children with rare forms of diabetes

The pancreas is responsible for making a huge number of hormones, including insulin. This hormone helps our bodies control blood sugar levels: if we are unable to produce enough insulin, it can cause life-threatening problems, such as diabetes.

While type 1 and type 2 diabetes are the most well-known forms, Great Ormond Street Hospital has a large team that specialises in treating children with rarer varieties caused by faulty genes affecting their insulin-producing cells. The hospital also sees children with secondary diabetes triggered by transplants, treatments or conditions like cystic fibrosis.

Consultant endocrinologist Dr Rakesh Amin is leading a research study on improving diabetes outcomes at the hospital: "With diabetes, you have an extraordinarily simple blood measurement, which accurately predicts current and future problems," explains Dr Amin. "Because diabetes is a lifelong condition, traditionally, doctors have said it will take a year or two for patients to get used to managing their condition.

"However, using this simple test, we've recently shown that if you achieve excellent diabetes control within the first year, then this is likely to remain in future years. The reverse is also true. We're trying to use this information to shape the way patients are being treated, leading to benefits for them and the NHS in the long-term."

Left: 18-year-old Shannon has been coming to Great Ormond Street Hospital since she was a baby. She is treated for cystic fibrosis-related diabetes.





## Pancreas: the dangers of insulin

The pancreas is a complex organ responsible for more hormonal conditions than just diabetes. "With diabetes, you have high blood sugar levels and you use insulin to treat it," says Dr Pratik Shah, a clinician at Great Ormond Street Hospital specialising in hyperinsulinism (HI). "HI is the exact opposite: you have high insulin levels and sugar levels can fall to dangerously low levels."

The biggest complication in children who produce too much insulin is brain injury. "If sugar levels fall too low, the brain cannot function, so these children need treating quickly," warns Dr Shah. "There are two problems with the pancreas that cause HI. Both are lesions, but when you look into the microscope, you see that one is focal – where just one part of the pancreas is affected – and the other one is diffuse, where the lesions are scattered."

Focal lesions are easier to treat by using surgery, which can often lead to a cure. "But diffuse lesions are more challenging and surgery isn't always an option," says Dr Shah. Often, doctors at Great Ormond Street Hospital deal with these more complicated cases. Until around five years ago, the only option for severe diffuse disease was to remove 95 per cent of the pancreas. "This is huge surgery for a small baby, which can have complications and almost certainly leads to diabetes in later life," explains Dr Shah.

Instead, Dr Shah and his team are now leading work to uncover new drug treatments to help avoid brain injury in early life, but also to offer an alternative to radical surgery.

**Right: four-year-old Scarlett was born with the extremely rare condition congenital hyperinsulinism, which affects around one in 50,000 people.**

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**2010** Great Ormond Street Hospital and University College London begin offering a special scan to help diagnose children requiring treatment for hyperinsulinism, instead of patients having to travel to Berlin.





## Ciara's story

**Ciara's mum, Sharon, shares her family's experience of coming to Great Ormond Street Hospital for her daughter's treatment.**

"Ciara is looked after by the hyperinsulinism (HI) team at Great Ormond Street Hospital and has been coming to the hospital since April 2010. She was transferred after two hospitals near our home in southern Ireland found it difficult to treat her for this rare genetic condition.

"Our first journey was during the volcanic ash cloud in Iceland and no planes were allowed to fly. A bed had become available at the hospital, so an emergency plan was put in place where we were given permission to fly to London in the government's private jet!

"The HI team, run at the time by Dr Khalid Hussain and his amazing HI nurses, was an immediate lifeline for Ciara. They knew exactly what they were doing, had years

of experience in HI and turned her life around. She left GOSH after three months and we returned home to Ireland with treatment of four injections a day.

"At Christmas four years ago, we got a call from Dr Pratik Shah about a new type of medication that might be available. Ciara was chosen as one of the first children to trial the drug. It meant we travelled back to the hospital about 10 times that year, but it was all worth it because Ciara went from four injections a day to one a month! It changed her life and that of our family forever. It means that we don't have to be with her at all times – she can go for sleepovers and play with her friends and that is so important."

**Right: seven-year-old Ciara.**





## Meet the team

**Treating and supporting children with hormonal conditions is a team effort, involving many different people from a variety of disciplines across Great Ormond Street Hospital. Working together, they can embark on vital breakthroughs for children with these conditions.**

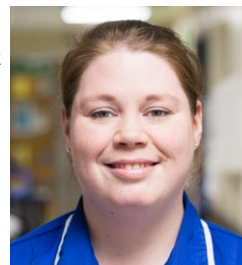
### **Abigail Atterbury**

Clinical Nurse Specialist (pituitary disorders and septo-optic dysplasia)

"No two days are the same when working as an endocrine nurse specialist: one day I'm on the wards meeting with children and their families with newly diagnosed endocrine conditions, the next I can be talking to schools and community nurses about how to ensure a child or young person can be cared for safely in the community. Planning is never easy!

"The best thing about this job is being able to support families clinically and emotionally. Most endocrine conditions are lifelong, so a lot of support is required initially and throughout their time at the hospital (and sometimes after!).

"It's great to be able to go home at the end of the day with a smile on my face knowing that I've helped and supported my patients and their families."







## Clare Gilbert

Clinical Nurse Specialist (hypoglycaemia)

"Having worked at GOSH for nearly 20 years, I've seen first-hand, and been involved in, the huge advances made in the treatment of our patients with hyperinsulinism. Although rare, this condition can have devastating consequences if blood glucose is allowed to fall, including damage to the brain.

"Through the dedication of the whole team, this condition can now be treated and in some cases even cured. My role is a privileged one and being able to work with our patients from birth to adolescence is wonderful. Our daily aim is always to try to prevent blood sugar dropping dangerously low, minimising the risk of consequences and enabling our patients to all reach their potential."



## Tarryn Klotnick

Social Worker

"It's been a privilege to be a social worker in the endocrine team for the past seven years. There are lots of dimensions to the work I do – from signposting families to practical support, to talking with them about the complex emotions that come with a diagnosis. There can be a lot of uncertainty involved and being on the ward can be isolating.

"The whole experience can be exhausting for patients and parents. I also try to ensure families are supported to manage their child's care at home, including advocating for support in the community. Essentially, I'm there to try and make things easier, and even though I don't carry a magic wand to solve problems, 'a problem aired is a problem shared' and this can make a huge difference to families."







## Adrenal: the rush to find cures for adrenal disorders

Located at the top of the kidneys, the adrenal glands release important hormones for health and growth. Children with serious adrenal conditions need emergency care soon after birth to quickly replace vital hormones and salts. They will subsequently need lifelong treatment and care.

Researchers at Great Ormond Street Hospital have been investigating ways to personalise treatments and minimise side effects for these children. John Achermann, Professor of Endocrinology at the UCL Great Ormond Street Institute of Child Health and Wellcome Trust Senior Research Fellow, specialises in finding genetic causes for adrenal conditions.

"We've developed a way of rapidly analysing the DNA of about 150 genes at a time. In a recent collaboration with the

Turkish Paediatric Endocrine Society, we examined the genes of 95 children with undiagnosed adrenal conditions and made a diagnosis in 80 per cent of the children," explains Professor Achermann.

"We're now finding a genetic cause for many conditions. For example, in 1994, we discovered the gene for a condition that mainly affects males, known as X-linked congenital adrenal hypoplasia, which is now part of a standard UK test. We're leading the field in bringing rare forms of adrenal conditions into a clinical setting to help diagnose and treat more children."

Four-year-old Max has a rare form of adrenal hyperplasia, which was only diagnosed thanks to Professor Achermann's work: "We'll be eternally grateful to Professor Achermann," says Max's mum, Hannah. "When Max was on the right treatment, his health started to improve and we could return to a more normal family life."

**Left: John Achermann. Inset: Max is enjoying life as a happy, healthy young man.**



One-year-old Adam comes to Great Ormond Street Hospital with his mum, Alba, for treatment.





**TOMORROW**









## The future for children with diabetes

The diabetes team at Great Ormond Street Hospital are embracing the use of technology in order to better deliver insulin and monitor glucose levels and hope to take it even further. "We're now using pumps that continuously deliver insulin into the body, and with a few clicks of a button, they can deliver extra doses to cover high-need periods," explains consultant endocrinologist Dr Rakesh Amin.

Although insulin pumps are used worldwide, Great Ormond Street Hospital is one of the few places to use them to treat children with rare forms of diabetes. "The small pump sits in the pocket, which means the child is free to walk around at home or school. Instead of having to administer multiple injections a day, the child or carer can simply press buttons on the device to accurately deliver the medication they need," adds Dr Amin.

Continuous glucose monitor sensors can be used in parallel with the pumps. They sit on the skin, continuously monitoring blood glucose levels, and will play an important role in the future treatment of diabetes.

"Traditionally, children have to do finger prick blood tests to monitor glucose levels up to 20 times a day, including throughout the night," says Dr Amin. "But these revolutionary devices which are improving all the time, can continuously report glucose levels, either on a monitor or maybe even transmitted to a smartphone. Excitingly, they can also be linked to an insulin pump to ensure that the child receives the right amount of insulin exactly when they need it."

Left: seven-year-old Yuki with an insulin pump.



## A brighter future for children with hyperinsulinism

Dr Pratik Shah and the team treating children who produce too much insulin are aiming to revolutionise the quality of life and treatment options for these young people. "One of the things we're currently looking at is whether we can use CT scans with a special molecule that highlights the areas of the pancreas that are overproducing insulin," explains Dr Shah. This procedure would allow surgeons to more accurately remove lesions and improve the outcomes of surgery.

"Often these children will develop diabetes later in life," explains Dr Shah. "That's hard because it continues having an effect on their whole life. Our main aim is to try and treat them when they are little and the disease is more severe. If we could do that through drug treatment, that would be ideal."

The new drugs not only need to be effective, but also improve quality of life. "The current drug does work in controlling hyperinsulinism (HI) in these children, but they need four injections a day," emphasises Dr Shah. "Our dream is to use a different drug with only one injection a month. We're doing a trial to see if this is effective – it could hold great promise for the future.

"Realistically, this won't work for all children. So my role is to try and develop new therapies for those children. Currently, there are a couple of newer therapies, and as one of only two HI specialist centres in the UK, Great Ormond Street Hospital is ideally placed to research and test them."

Right: 14-year-old Josh with Abigail Atterbury,  
Clinical Nurse Specialist on Rainforest Ward.





## My Cortisol: the smartphone life-saver

Sally Tollerfield, Endocrine Clinical Nurse Specialist (CNS), has developed a smartphone app called 'My cortisol' to help families give a life-saving injection when their child is experiencing an adrenal crisis.

Adrenal crisis is a life-threatening risk for patients with cortisol deficiency, and so the CNS team spend a lot of time training families how to give the cortisol injection required in an emergency. "As the majority of the young people we see are outpatients, it's vital we do as much as possible to help them at home and in the community," explains Sally.

"Working with teams across the hospital we created an app to support the training. We settled on five tabs to make it easy to navigate. As well as the instruction video, the app can store medication details and has a page for medical professionals.

"We show patients and families the app when we deliver training, and they can then go home and show it to other family and friends. It's been life-transforming for many. One mum told us she's able to book a babysitter as it's finally made other people confident to look after her son."

Even though the app has only been promoted internally, it has already been downloaded almost 4,500 times and has received overwhelmingly positive reviews from families and professionals.

Right: 16-year-old Monica and her mum, Juliet, learning how to give a cortisol injection.







## My Cortisol: Hope's story

**Singer-songwriter Hope talks about the impact that the app My Cortisol has had on her life.**

"I have a tumour in my pituitary gland, which affects the levels of some of the hormones in my body – mainly cortisol.

"My cortisol production is very low, so my body doesn't react like most people's would in an accident. For instance, if I broke my leg, adrenaline would usually kick in and cortisol would rush through the body to help that person cope, but instead, my body effectively shuts down."

"I take cortisol tablets four times a day, and can also have an injection if my levels suddenly, dangerously, drop. It's not a simple injection, so it can be nerve-wracking for someone trying to help me in an emergency. The app has made a real difference.

"It really came into play when I wanted to take part in the Duke of Edinburgh Award expedition, which consisted of a 26km kilometre walk and overnight camping. My close circle of friends all downloaded the app and each had designated roles so they were clear on what they needed to do in an emergency. Luckily, we had no need to use it, but if it hadn't been available, I probably wouldn't have been able to take part.

"My condition is very rare, so it's also great to have the app to help explain. Life is so much easier now, and I feel more able to do things that anyone else can do – I know if it's there on my phone I can say 'Look, this is what you need to do'."

Right: 17-year-old Hope.



Photo: Clem Morris



Thank you

## Thank you

We've come a long way since the Hospital for Sick Children opened in 1852. The hospital's dedicated and passionate staff have pioneered many new and better ways of treating children with some of the most life-threatening conditions. But we are yet to find a cure for all of the patients that come to Great Ormond Street Hospital.

Throughout the hospital's history, it has been the continued and generous support of our donors that has helped to fund the research that provides new breakthroughs. With your ongoing generosity, we seek to give hope to all children that need the hospital's specialist help.

Right: Joshua, age three, comes to Kingfisher Ward to be treated for adrenal insufficiency.







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## FIND OUT MORE

Our website has more information about the specialists, patients and treatments you've read about in this guide, as well as the pioneering research Great Ormond Street Hospital carries out.

If you'd like to find out more, or you have your own stories that you'd like to share with us, please visit [\*\*gosh.org/breakthroughs\*\*](https://gosh.org/breakthroughs)



We need to raise money to continue to support the legacy of breakthroughs at the hospital. Your donations are used to fund groundbreaking research, advanced equipment, child and family support services, and the rebuilding and refurbishment of new wards and facilities.

These are just some of the developments that have taken place since the hospital opened in 1852. Extraordinary things continue to happen at Great Ormond Street Hospital every day.

Great Ormond Street Hospital Children's Charity.  
Registered charity no. 1160024.

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